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Abstract title: Motion Compensation for Ultra Wide Band SAR

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Abstract:

The character of ultra wide band (UWB) synthetic aperture radar (SAR) data acquired from an airborne platform invalidates most conventional SAR batch processing algorithms. Batch processing algorithms generally assume that the target is located in the antenna fan beam plane and thus do not support motion compensation that is a function of the target location within the antenna beam, a necessity for optimal processing of strip map UWB data acquired from a radar platform moving along a track deviating from a straight line. Spotlight processing type algorithms, such as the polar format processor, does account for the along track variation of the line-of-sight aspect angle change, however, such algorithms only provide high processing fidelity in a small neighborhood of the central patch reference.

This paper describes an algorithm that combines wavenumber domain processing with a procedure that enables motion compensation to be applied as a function of target range and azimuth angle. The basic idea to be employed processes the data in two steps. First the data is processed with a standard motion compensation approach that assumes the target is located in the fan beam plane. The first order motion compensation and image focussing will partially focus the image thus ensuring that the target energy acquired over an extremely long aperture (e.g. a 5 to 10 km flight line) will be focussed to first order (e.g. 10 to 100 m). Following this first order focussing, the image is divided into subpatches, which are reprocess to refine the motion compensation correction. The reprocessing step takes into account the signal processing already applied during the initial steps and will implement a motion compensation scheme that corrects each target's signal energy appropriately as a function of the azimuth aspect angle.

A combination of radar parameters and flight profiles, of relevance for an actual UWB system design, was used to simulate the performance of the algorithm. The results show that the proposed algorithm is very effective in compensating for deviations from a straight flight path, both from a performance and a computational efficiency point of view.

The algorithm presented is being applied in the GeoSAR project, an on-going airborne SAR development at JPL. The GeoSAR sensor consists of interferometric UHF and X-band channels. The single look resolution of the data is, in the high-resolution mode, on the order of a meter. The algorithm presented in this paper was developed to meet this resolution requirement even in case on severe aircraft motion.

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